MARKETING RESEARCH REPORT NO.969

LOCATIONAL MODELS FOR COTTON GINNING AND WAREHOUSING FACILITIES

ECONOMIC RESEARCH SERVICE
U.S. DEPARTMENT OF AGRICULTURE

ABSTRACT

Costs associated with cotton ginning and warehousing for conventional plant arrangements and theoretical models are analyzed and compared. The proposed models incorporate maximum known efficiencies in plant size selection and latest available technologies in processing and handling. Also described are possibilities of reducing by up to one-third or more the cost per bale of providing four marketing services--seed cotton assembly, gin processing, transporting baled lint from gin to warehouse, and warehouse receiving.

Keywords: Seed cotton assembly, Ginning, Warehousing, Locational models, Marketing services, Costs.

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Washington, D.C. 20250 August 1972

HIGHLIGHTS

Cost per bale of providing four cotton marketing services was $18.45 in the first and $16.85 in the second of two locational models of optimum conditions for cotton ginning and warehousing facilities. In conventional operations (12-bale per hour gin plant), cost was $25.40 per bale. In comparison, use of Locational Model II would reduce operating cost one-third and increase efficiency.

The four services--seed cotton assembly, gin processing, transporting baled lint from gin to warehouse, and warehouse receiving--account for a substantial part of total marketing cost of cotton shipped to domestic mills. Locational Model I consisted of combined centralized ginning and warehousing facilities; Locational Model II included a centrally located warehouse surrounded by four large gin plants uniformly distributed throughout the production area.

Estimates assumed ginning facilities associated with the models would process 90 percent of potential seasonal volume, on the average; whereas, conventional facilities might process only 60 percent.

When it was assumed that seasonal ginning volume was a maximum and trailers were used 10 times each season, costs of the four services would be $17.80 per bale in Locational Model I, $16.30 in Locational Model II, and $21.16 conventionally.

Both models included the most efficient gin sizing techniques, proved technological developments in ginning machinery and equipment, and the latest handling methods for seed cotton and baled lint.

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by

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INTRODUCTION

Background and Limitations

Cotton growers pay most of the costs of marketing cotton either directly as out-of-pocket expenses or indirectly through lower cotton prices. Attempts to pass increased marketing costs on to fiber users usually cause further reduction in cotton's competitiveness in both domestic and foreign markets. Thus, many cotton growers want to reduce cost and market their crops more efficiently.

Numerous studies of the cost and efficiency of ginning have been made. Relatively fewer studies have focused on cost and efficiency of hauling seed cotton to gins and handling, storing, and shipping baled lint. Their findings have led to improved performance of individual cotton marketing services. These gains, however, have been more than offset by increases in wage rates and prices for other items used by firms providing marketing services.

Objectives of many studies were limited to bettering the efficiency of a single service provided by a particular group of firms, such as gins in a given area. Interrelationships between the particular group and firms performing other closely related services often were not analyzed. As a rule, it was assumed in such research that existing organizational relationships and operating methods were conducive to maximum efficiency, and that ginning and warehousing facilities were optimally located to provide low-cost services. These assumptions ruled out opportunities for analyzing interrelationships among marketing services performed by growers, ginners, warehousemen, and other segments of the cotton marketing system. Thus, possibilities were greatly restricted for researching potential changes relative to ownership structure and organization, services provided, and plant location which might lead to substantial reduction in cotton marketing costs.

Because of this concentration on narrowly defined problem areas, research findings often were not integrated so as to permit evaluation of the efficiency of part or all of the cotton marketing system.

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Purpose and Method of Study

In view of limitations of earlier research, a broader field was chosen for analysis, including (1) hauling seed cotton from field to gin, (2) ginning and packaging, (3) moving baled lint to warehouses, and (4) warehouse receiving.

These four services were treated as a single problem area for cost analysis--a logical choice. As cotton is harvested, these services are performed in relatively rapid succession, ending with stacking of bales in storage compartments where they may remain from a few weeks to more than a year before shipment. Also, the efficiency of performing any one of these services depends somewhat on the efficiency with which the others are performed. Finally, combined costs of these four services account for a substantial portion of total marketing costs of cotton shipped to domestic mills.

With the four services defined as a single problem area, the purpose of this study was to analyze alternatives for improving efficiency and reducing cost of transforming newly harvested seed cotton into baled and stored lint.

The first step was to describe and develop typical costs for the four services as currently performed. This analysis provided a logical basis for proposing changes in their present relationship; some operations could be eliminated, timing of others could be changed, and ginning and storage facilities could be relocated. From individual and total costs, effects of proposed changes on marketing efficiency and cost were evaluated.

The second step was to develop locational models for ginning and warehousing plants. The two models represent theoretical concepts, rather than any plant organization and locational arrangements currently in existence.

Maximum use was made of earlier research. When supplemental information was needed, relevant input-output data and prices were secured directly from a few appropriate firms. Costs were synthesized from these data for each of the four marketing services and the two locational models.

Because of differences in operating practices and wide variations in wage rates and other costs throughout the Cotton Belt, the geographical scope of the study was restricted to one region. California-Arizona was selected mainly because it was thought to contain the corporate-type management and financial base required for the models.

Cost figures in this report may need to be supplemented or changed to make them more applicable to specific local situations. In fact, data were not intended to be representative of all cotton marketing firms in the study area but were used primarily to point out relationships among various marketing services and costs of performing them, and to simplify development of necessary methodology and approach.

Other problems became more evident during the study. These are pointed out with suggestions which, hopefully, will be beneficial in formulating objectives for future research on cotton marketing costs.

DESCRIPTION AND COSTS OF CURRENT MARKETING SERVICES

In developing total costs for each of the four conventional marketing services, both fixed and variable inputs and their costs were considered. Fixed costs were those associated with equipment and permanent facilities; they are constant in the short run, always present, and obligated even at zero output levels. Variable costs depend on volume, usually rising less as volumes increase.

Hauling Seed Cotton

Cost and responsibility of hauling seed cotton to gins are generally borne by growers. Thus, marketing costs are higher for growers farther from the gins. Hauling the cotton requires trailers, motive power, and labor. For this report, the most typical combination was assumed to be a 4-wheel trailer with a seed cotton capacity of 6 bales (lint equivalent) and a half-ton pickup truck with driver.

In general, depreciation, interest, insurance, and property taxes are the principal fixed costs of operating a pickup truck; fuel, oil and grease, tires, repairs, and maintenance are the major variable cost items. Both types of cost were estimated per mile since pickups are used for other farm jobs during the cotton harvest (table 1).

Trailer costs have been handled in various ways. In one report, depreciation and interest on investment were shown as fixed costs, with tires, repairs, and paint considered as variable costs (9). 2/ In another, all costs were treated as fixed, on the assumption that tires, paint, and other cost items would deteriorate over time regardless of use (1). In this report, trailer costs were considered fixed since many trailers in California and Arizona are left out of doors year round. Annual cost of cotton trailer operation was estimated at $167.50 (table 2). Thus, one trip per season would cost $27.92 per bale; 10 trips would reduce the amount to $2.79 (table 3).

Actual requirements in man-hours for the pickup driver are determined by hauling distance, average road speed between field and gin, and time consumed at each end of the trip. In this report, it was estimated that the driver's labor would range from $0.56 a bale for a round trip travel distance from field to gin of 2 miles to $1.20 a bale for a round trip of 50 miles (table 4).

Estimates of total hauling costs of seed cotton by travel distance and number of trips per trailer are shown in table 5. Number of seasonal uses per trailer has a much greater effect on hauling cost than does travel distance. For example, if trailer use could be increased from 10 to 12 times per season, travel distance could be extended about 13 miles without affecting cost per bale.

2/ Underscored figures in parentheses refer to items in Literature Cited.

Table 1.--Annual operating costs for half-ton farm pickup truck, California-Arizona, 1971

Cost item	Cost 1/ Annual	Per mile	Per bale-mile 2/
	Dollars		
Fixed costs:			
Depreciation 3/	687.50	0.0458	0.0076
Interest 4/	120.75	.0080	.0013
Insurance 5/	139.05	.0093	.0016
Taxes 6/	51.75	.0035	.0006
Subtotal	999.05	.0666	.0111
Variable costs:			
Gasoline 7/	659.10	.0439	.0073
Tires 8/	140.00	.0093	.0016
Repairs	150.00	.0100	.0017
Servicing	55.00	.0037	.0006
Subtotal	1,004.10	.0669	.0112
Total costs	2,003.15	.1335	.0223

1/ Annual operation estimated at 15,000 miles.
2/ Assumes only 1 fully loaded 6-bale trailer hauled per trip.
3/ Based on replacement value of $3,450, depreciation rate of 25 percent, and salvage value of $700.
4/ Based on rate of 7 percent applied to half the replacement cost.
5/ Coverage assumed involved $100,000/$300,000 personal liability, $10,000 property damage, $100-deductible collision, $50-deductible comprehensive, and uninsured motorist.
6/ Includes license.
7/ Consumption rate--7-1/2 miles per gallon at $0.329 per gallon.
8/ One set of 4 tires annually.

Ginning and Packaging

Ginning inputs, costs, and related data summarized in this section came from a report recently published by the U.S. Department of Agriculture (USDA) (13). In that study, 10 model gin plants were developed for each of the three major cotton-growing regions, one of which included the California-Arizona area. Because the latest ginning technologies and current input and cost data were used to develop these models, the findings are current and applicable and were adopted here. Actual ginning rates, potential seasonal volumes, and capital requirements for six of these models are summarized in table 6; seasonal ginning costs per

Table 2.--Annual operating cost, 6-bale trailer, California-Arizona, 1971

Cost item	Cost
	Dollars
Depreciation 1/	96.80
Interest on investment 2/	35.70
Tires 3/	15.00
Miscellaneous 4/	20.00
Total	167.50

1/ Based on replacement value of $960, depreciation rate of 8 percent, and no salvage value. Also includes depreciation rate of 33-1/3 percent on $60 tarpaulin used to cover seed cotton in transit.
2/ Based on rate of 7 percent applied to half the replacement cost of trailer and tarpaulin.
3/ 1 tire (used) per year.
4/ Includes repairs, maintenance, and property tax.

Table 3.--Cost per round trip and per bale for use of 6-bale seed cotton trailer, by number of times used per season, California-Arizona, 1971

Number of times used	Cost per round trip	Cost per bale 1/
	Dollars	
1	167.50	27.92
2	83.75	13.96
4	41.88	6.98
6	27.92	4.65
8	20.94	3.49
10	16.75	2.79
12	13.96	2.33
14	11.96	1.99
16	10.47	1.74

1/ Assuming trailer is fully loaded for each use.

Table 4.--Labor costs per bale for assembling seed cotton, by round trip distance, California-Arizona, 1971

Total travel distance (miles)	Labor 1/		
	Fixed 2/	Variable 3/	Total
	Dollars		
2	0.5333	0.0266	0.5599
4	.5333	.0532	.5865
6	.5333	.0798	.6131
8	.5333	.1064	.6397
10	.5333	.1330	.6663
12	.5333	.1596	.6929
14	.5333	.1862	.7195
16	.5333	.2128	.7461
18	.5333	.2394	.7727
20	.5333	.2660	.7993
30	.5333	.3990	.9323
40	.5333	.5320	1.0653
50	.5333	.6650	1.1983

1/ Based on average wage rate of $2.40 an hour and 6 bales (lint equivalent) per trailer load of seed cotton.
2/ Based on 1.3333 man-hours a trip (field and gin turnaround time).
3/ Based on 0.0333 man-hours a mile of travel time to and from gin, or $0.0133 per bale-mile.

bale are itemized in table 7. The trend to larger gins to keep pace with increases in harvest rates, the incorporation of more conditioning equipment to maintain lint quality, and the general increases in machinery and equipment costs are primarily responsible for the relatively large capital investments in gin plants.

Rated capacities (gin machinery manufacturers' ratings under optimum operating conditions) for the six models range from a low of 6 bales per hour to a high of 36. However, optimum conditions seldom prevail for extended periods of time; thus, 85 percent of manufacturers' rated capacity probably more accurately reflects the actual hourly processing rate (20, 21, 22, 23, 24).

The cotton crop is very seasonal; gins need to be "open for business" only about 30 percent of the year. Furthermore, the harvest is slow and irregular during early and late weeks of the season, resulting in costly idle time for plants and crews during these periods. During peak weeks of harvest, some time is lost because of "shutdowns" for routine cleaning and maintenance or emergency repairs. It was assumed that during the average season, a typical gin was open with a paid crew on duty for approximately 1,320 hours, although only about 906 hours were spent in ginning.

Table 5.--Seed cotton assembly cost, by travel distance and number of seasonal trips per trailer, California-Arizona, 1971 1/

Total travel distance (miles)	Trips per trailer								
	1	2	4	6	8	10	12	14	16
	Dollars per bale								
2	28.52	14.56	7.58	5.26	4.09	3.40	2.93	2.60	2.35
4	28.59	14.63	7.65	5.33	4.17	3.47	3.00	2.67	2.42
6	28.66	14.71	7.73	5.40	4.24	3.54	3.07	2.74	2.49
8	28.73	14.78	7.80	5.47	4.31	3.61	3.14	2.81	2.56
10	28.81	14.85	7.87	5.54	4.38	3.68	3.22	2.88	2.63
12	28.88	14.92	7.94	5.61	4.45	3.75	3.29	2.95	2.71
14	28.95	14.99	8.01	5.68	4.52	3.82	3.36	3.03	2.78
16	29.02	15.06	8.08	5.76	4.59	3.89	3.43	3.10	2.85
18	29.09	15.13	8.15	5.83	4.66	3.97	3.50	3.17	2.92
20	29.16	15.20	8.22	5.90	4.73	4.04	3.57	3.24	2.99
30	29.52	15.56	8.58	6.25	5.09	4.39	3.93	3.60	3.35
40	29.87	15.92	8.94	6.61	5.45	4.75	4.28	3.95	3.70
50	30.23	16.27	9.29	6.97	5.80	5.10	4.64	4.31	4.06

1/ Based on fixed costs of $167.50 for 6-bale trailer and $0.5333 per bale (1.3333 man-hours at $2.40) for labor; and variable costs per bale-mile of $0.0223 for the truck and $0.0133 per bale-mile (0.0333 man-hours at $2.40) for labor.

When seed cotton is unloaded at gins with capacities up through 12-16 bales per hour, a single suction pipe is required. For larger gins, a second suction pipe and additional seed cotton cleaning and conditioning equipment are needed. Likewise, a conventional, semiautomatic gin press is adequate for gin sizes through 24 bales per hour. For gins with capacities of 30-36 bales per hour, an automatic gin press must be used. One manufacturer, and perhaps others, offers an automatic press capable of pressing to a density of 28-30 pounds per cubic foot (5, 6, 17, 18). This capacity is only slightly higher than the 20-25 pound density normally employed for domestic shipments (standard density) and just under the 32-35 pound density customarily used for export shipments (high density). If 28-30 pound density could be accepted as universal for both domestic and export shipments, further compression of bales packaged by one of these presses would be eliminated. Besides this obvious cost saving potential, less labor is needed to operate this press compared with a conventional gin press.

Estimates of total ginning costs per bale for the six model gins operating at full capacity ranged from a high of $18.85 for the 6-bale per hour plant to a low of $12.80 for the 36-bale per hour plant. However, seasonal volumes of many plants are appreciably lower than their potentials; thus, actual costs per bale would be much higher than the above estimates. For example, if a

Table 6.--Actual ginning rates, potential seasonal volumes, and estimated capital requirements for six model gin plants, by rated capacity, California-Arizona, 1971 1/

Item	Rated bale capacity per hour 2/					
	6	12	18	24	30	36
Actual ginning rate 3/	5.1	10.2	15.3	20.4	25.5	30.6
	Bales					
Potential seasonal volume 4/	4,620	9,240	13,860	18,480	23,100	27,720
	1,000 dollars					
Capital item:						
Land 5/	12	14	18	20	25	30
Gin buildings 6/	40	50	60	80	105	130
Gin machinery	160	250	360	490	630	770
Outside equipment 7/	13	16	17	26	36	40
Tools	2	3	3	4	5	6
Office buildings 8/	9	11	12	14	18	22
Total	236	344	470	634	819	998

1/ (13).
2/ Manufacturers' ratings, 1 processing line.
3/ 85 percent of manufacturers' rated capacities.
4/ Based on actual ginning rates, assumes plants operate 906 hours during season.
5/ Based on estimated land value of $1,000 per acre.
6/ Includes foundation.
7/ Includes cyclones, piping, seed hopper, bale trailers, tractors, truck and auto.
8/ Includes furniture, fixture, and scales.

6-bale per hour plant processed only 70 percent of its potential, it would gin only 3,234 bales rather than 4,620 bales; total costs would average $22.57 a bale rather than $18.85, a difference of $3.72 per bale (table 8).

Hauling Bales to Warehouse

In California and Arizona, the typical tractor-trailer combination for hauling cotton from gins to warehouses can hold 80 flat bales or 100 gin standard bales. These hauling rigs are equipped with mechanically operated hoists for loading bales at the gin yard. The driver, aided by one or two helpers, loads and secures the bales on the trailer and delivers them to a designated warehouse. Clamp-truck operators at the warehouse unload and position the bales in the receiving area.

Table 7.--Estimated seasonal costs per bale for modern gin plants, by cost item and rated capacity, California-Arizona, 1971 1/

Cost item	Rated bale capacity per hour 2/					
	6	12	18	24	30	36
	Dollars					
Fixed costs: 3/						
Depreciation	2.42	1.79	1.63	1.66	1.72	1.75
Interest	1.88	1.36	1.23	1.24	1.28	1.30
Insurance	.44	.36	.34	.35	.35	.36
Taxes	.84	.61	.56	.56	.58	.59
Management	2.05	1.62	1.47	1.40	1.36	1.33
Subtotal	7.63	5.74	5.23	5.21	5.29	5.33
Variable costs:						
Labor	3.78	2.96	2.45	2.19	1.76	1.58
Energy	1.13	.77	.76	.69	.74	.71
Bagging and ties	3.00	3.00	3.00	3.00	2.50	2.50
Repairs	1.61	1.52	1.43	1.34	1.26	1.18
Miscellaneous	1.70	1.66	1.62	1.58	1.54	1.50
Subtotal	11.22	9.91	9.26	8.80	7.80	7.47
Total costs	18.85	15.65	14.49	14.01	13.09	12.80
	Bales					
Seasonal volume 4/	4,620	9,240	13,860	18,480	23,100	27,720

1/ (13).
2/ Manufacturers' ratings, 1 processing line.
3/ Slight increases in some fixed cost items for 3 largest gin models due to increased investments in more and larger machinery and equipment.
4/ Assumes plants operate at full actual capacity entire season.

The rate for hauling baled cotton is based primarily on handling and travel distance. The linear regression equation used to estimate the charge for this service was $Y = .8 + X$, where Y was the charge per bale in dollars and X was any travel distance between 10 and 100 miles (4).

A frequency distribution of mileage from gin plants to the nearest storage facilities in the two-State area was used to determine typical hauling distances. Approximately 75 percent of these distances were fairly evenly distributed between 20 and 80 miles. Thus, the following charge schedule by miles traveled was considered typical: 10 miles or less--$0.90; 20 miles--$1.00; 40 miles--$1.20; 60 miles--$1.40; and 80 miles--$1.60.

Table 8.--Estimated total costs per bale for modern gin plants, processing selected percentages of potential seasonal volume, by rated capacity, California-Arizona, 1970-71 1/

Proportion of potential volume and type of costs	Unit	Rated hourly bale capacity 2/					
		6	12	18	24	30	36
100 percent	Bales	4,620	9,240	13,860	18,480	23,100	27,720
Costs:							
Fixed	Dol.	7.63	5.74	5.23	5.21	5.29	5.33
Variable	do.	11.22	9.91	9.26	8.80	7.80	7.47
Total	do.	18.85	15.65	14.49	14.01	13.09	12.80
90 percent	Bales	4,158	8,316	12,474	16,632	20,790	24,948
Costs:							
Fixed	Dol.	8.37	6.27	5.71	5.70	5.78	5.81
Variable	do.	11.45	10.10	9.41	8.96	7.95	7.64
Total	do.	19.82	16.37	15.12	14.66	13.73	13.45
80 percent	Bales	3,696	7,392	11,088	14,784	18,480	22,176
Costs:							
Fixed	Dol.	9.31	6.93	6.32	6.29	6.39	6.42
Variable	do.	11.71	10.32	9.63	9.16	8.15	7.84
Total	do.	21.02	17.25	15.95	15.45	14.54	14.26
70 percent	Bales	3,234	6,468	9,702	12,936	16,170	19,404
Costs:							
Fixed	Dol.	10.51	7.80	7.09	7.05	7.18	7.20
Variable	do.	12.06	10.59	9.90	9.40	8.35	8.03
Total	do.	22.57	18.39	16.99	16.45	15.53	15.23
60 percent	Bales	2,772	5,544	8,316	11,088	13,860	16,632
Costs:							
Fixed	Dol.	12.11	8.95	8.12	8.09	8.21	8.25
Variable	do.	12.48	10.94	10.22	9.72	8.64	8.32
Total	do.	24.59	19.89	18.34	17.81	16.85	16.57
50 percent	Bales	2,310	4,620	6,930	9,240	11,550	13,860
Costs:							
Fixed	Dol.	14.36	10.55	9.56	9.52	9.68	9.73
Variable	do.	13.16	11.39	10.64	10.12	9.02	8.66
Total	do.	27.52	21.94	20.20	19.64	18.70	18.39

1/ (13).
2/ Manufacturers' ratings, 1 processing line: actual processing rate 85 percent of rated capacity.

Warehouse Receiving

For this report, warehouse receiving was defined to include unloading, tagging, weighing, sampling, and stacking bales in designated sections of the warehouse which, hereafter, are referred to as storage compartments. Data on equipment and labor inputs required in 1958 to perform these jobs were obtained from (19). Although some of it has changed, equipment currently used does not differ appreciably from that employed 10 years ago. Current rental and wage rates were used in updating input costs; the range was from \$3.31 to \$6.77 for unloading 100 bales by four different methods (table 9).

Labor was the only input considered in tagging bales. Based on an input of 0.2 man-hour per 100 bales and a wage rate of \$3.90 per hour, this cost was \$0.78 for 100 bales. Costs for three different weighing methods ranged from \$4.80 to \$9.82 per 100 bales (table 10).

Labor was also the major input required for sampling. Cutting and wrapping samples from 100 bales required 1.84 man-hours and at current wage rates cost \$7.18. When samples were rolled rather than wrapped, this cost was reduced to \$5.93 per 100 bales.

Cost of moving bales from the receiving area for stacking in the storage compartment depends on size of clamp truck, distance from receiving area to storage compartment, and stacked height of the bales. Costs for various combinations of these factors ranged from \$3.75 to \$15.27 per 100 bales (table 11).

Labor and equipment costs for unloading, tagging, sampling, weighing, and stacking were estimated at the peak of the receiving period, when inputs are being used most efficiently. However, warehouse plants are similar to gin plants in that labor and equipment inputs are not fully used during early and late weeks of the season. Therefore, to derive an estimate of seasonal average cost of receiving the bales, costs which prevailed at the peak of the season were increased 45.70 percent. 3/ Results of these computations of inputs for typical methods of receiving bales are summarized in table 12.

For a majority of warehouse plants in California-Arizona, the cost of labor and equipment for receiving cotton ranged from \$41.01 to \$45.64 per 100 bales because the 3-bale clamp truck was the most popular size. In a recent beltwide study of cotton warehousing costs, labor and equipment accounted for 85 percent of the total variable cost of receiving in the West, and variable cost represented 81 percent of total receiving cost (11). On this basis, total receiving cost ranged from \$59.57 to \$66.28 per 100 bales, depending on inplant travel distance and stacking height for bales (table 13).

3/ Development of an expansion factor was necessary to raise operating costs from those incurred at the peak of the season to those more typical of the overall season. It was assumed that equipment and labor inputs for warehouse receiving would be utilized at the same relative rates as facilities and labor at gins during any given period of the season. As indicated earlier, gins are "open for business" 1,320 hours but actually operate only 906 hours during a typical season. The resulting factor was 145.70 percent $(\frac{1320}{906})$.

Table 9.--Inputs and costs of labor and equipment for unloading 100 flat bales at peak of receiving period, by selected combinations of inputs, California-Arizona, 1971 1/

Item	Elapsed time	Input		Cost of input 2/		
		Equipment	Labor	Equipment	Labor	Total
	Hours	Machine-hrs.	Man-hrs.	Dollars		
Platform level:						
1 man, 3-bale clamp truck 3/	0.61	0.61	0.61	2.01	2.38	4.39
2 men, 3-bale clamp truck 4/	.61	.61	1.22	2.01	4.76	6.77
Ground level:						
1 man, 3-bale clamp truck...	.61	.61	.61	2.01	2.38	4.39
1 man, 4-bale clamp truck...	.46	.46	.46	1.52	1.79	3.31

1/ Input data obtained from (19), pp. 22-24); assumes input utilization at maximum efficiency.

2/ Equipment costs based on the following rental rates per machine-hour: 3- and 4-bale clamp trucks--$3.30. Labor costs based on unit cost of $3.90 per man-hour, including fringe benefits.

3/ Assumes clamp truck permitted on truck-trailer bed, hence, only 1 man needed.

4/ Assumes clamp truck not permitted on truck-trailer bed; hence, additional man needed to shift half of load to platform side of truck.

Combined Costs

Combined costs of hauling seed cotton from field to gin, ginning, hauling baled lint from gin to warehouse, and warehouse receiving, as already noted, depend on numerous variables; such as, travel distance, size and use of equipment or machinery, and efficiency of labor utilization. Thus, infinite combinations could have been formed to arrive at total costs of these four marketing services. However, the number was reduced to 648 by considering only:

(a) one average round trip travel distance for hauling seed cotton,
(b) nine levels of trailer use,
(c) six different gin plant models,
(d) six seasonal output levels for each gin model,
(e) two different travel distances for hauling bales to warehouses, and
(f) one labor-equipment combination and stacking condition for warehouse receiving service.

Table 10.--Inputs and costs of labor and equipment for weighing 100 flat bales in row blocks at peak of receiving period, by selected combination of inputs, California-Arizona, 1971 1/

Combination of inputs	Elapsed time	Input		Cost of input 2/		
		Equipment	Labor	Equipment	Labor	Total
	Hours	Machine-hrs.	Man-hrs.	Dollars		
5 men, hand propelled scale 3/......	0.48	0.48	2.40	0.46	9.36	9.82
4 men, hand propelled with lifts....	.41	.41	1.64	.43	6.40	6.83
3 men, motor propelled scale 4/......	.35	.35	1.05	.70	4.10	4.80

1/ Input data obtained from (19, pp. 28-29).
2/ Equipment costs based on the following rental rates per machine-hour: hand propelled mobile beam scale--$0.95; hand propelled mobile beam scale with pneumatic lifts--$1.05; motor propelled beam scale--$2.00. Labor costs based on unit cost of $3.90 per man-hour, including fringe benefits.
3/ Includes tagging bales.
4/ Does not include tagging bales.

Costs of these 648 combinations ranged from a high of $58.46 a bale 4/ to a low of $17.50 5/ (app. tables 1-6).

BASIS FOR PROPOSED CHANGES

Earlier research revealed that weighing, tagging, and recording bale numbers and weights at gins required 1.1 man-minutes a bale; when sampling was performed, an additional 1.3 man-minutes were needed. The combined total for tagging, weighing, recording, and sampling was 0.04 man-hour per bale (3). At $2.30 a man-hour, cost per bale of these operations would be only $0.092.

4/ Assumes average round trip hauling distance of 6.41 miles and one trip per trailer in assembling seed cotton, ginning at 6 bales per hour with gin operating at 50 percent capacity, hauling distance of 80 miles from gin to warehouse, and inplant warehouse travel distance of 1,000 feet and stacking of bales 3-high.

5/ Assumes average round trip hauling distance of 15.64 miles and eight trips per trailer in assembling seed cotton, ginning at 36 bales per hour with gin operating at full seasonal capacity utilization, hauling distance of 40 miles from gin to warehouse, and inplant warehouse travel distance of 1,000 feet and stacking of bales 3-high.

11.--Inputs and costs of labor and equipment for transporting and stacking 100 flat bales in storage compartments at peak of receiving period, by selected combinations of inputs, California-Arizona, 1971 1/

Item 2/	Elapsed time	Input		Cost of inputs 3/		
		Equipment	Labor	Equipment	Labor	Total
	Hours	Machine-hrs.	Man-hrs.	- - - - - -	Dollars	- - - - - -
1 man, 3-bale truck with stack 2-bales high and travel distance of--						
400 feet	0.93	0.93	0.93	3.07	3.63	6.70
600 feet	1.30	1.30	1.30	4.29	5.07	9.36
800 feet	1.68	1.68	1.68	5.54	6.55	12.09
1,000 feet	2.06	2.06	2.06	6.80	8.03	14.83
Stack 3-bales high and travel distance of--						
400 feet	.99	.99	.99	3.27	3.86	7.13
600 feet	1.35	1.35	1.35	4.46	5.26	9.72
800 feet	1.74	1.74	1.74	5.74	6.79	12.53
1,000 feet	2.12	2.12	2.12	7.00	8.27	15.27
1 man, 4-bale truck with stack 2-bales high and travel distance of--						
400 feet	.52	.52	.52	1.72	2.03	3.75
600 feet	.68	.68	.68	2.24	2.65	4.89
800 feet	.83	.83	.83	2.74	3.24	5.98
1,000 feet	.98	.98	.98	3.23	3.82	7.05
Stack 3-bales high and travel distance of--						
400 feet	.59	.59	.59	1.95	2.30	4.25
600 feet	.74	.74	.74	2.44	2.89	5.33
800 feet	.90	.90	.90	2.97	3.51	6.48
1,000 feet	1.06	1.06	1.06	3.50	4.13	7.63

1/ Input data obtained from (19, pp. 42-44).
2/ Bales stacked in "on-head" or on-end, upright position.
3/ Equipment cost based on the following rental rates per machine-hour: 3- and 4-bale clamp trucks--$3.30. Labor costs based on unit cost of $3.90 per man-hour, including fringe benefits.

Table 12.--Seasonal average cost of labor and equipment for receiving 100 flat bales of cotton, by selected combinations of inputs, California-Arizona, 1971 1/

Item	Unloading with 3-bale clamp truck 2/		Unloading with 4-bale clamp truck 2/	
	Hand propelled scale and 5 men 3/	Motor propelled scale and 3 men 4/	Hand propelled scale and 5 men 3/	Motor propelled scale and 3 men 4/
	Dollars			
1 man, 3-bale truck with stack 2-bales high and travel distance of--				
800 feet	46.96	41.01	45.38	39.44
1,000 feet	50.95	45.00	49.37	43.43
Stack 3-bales high and travel distance of--				
800 feet	47.60	41.65	46.02	40.08
1,000 feet	51.59	45.64	50.02	44.07
1 man, 4-bale truck with stack 2-bales high and travel distance of--				
800 feet	38.05	32.11	36.48	30.54
1,000 feet	39.61	33.67	38.04	32.10
Stack 3-bales high and travel distance of--				
800 feet	38.78	32.84	37.21	31.27
1,000 feet	40.46	34.51	38.88	32.94

1/ Seasonal average cost computed by multiplying costs of performing individual operations at peak operating period by 145.70 percent, the ratio of gin labor inputs paid to those actually used.

2/ Unloading done at ground level. Cost of $5.93 for drawing and rolling samples was included in all computations; costs would be $1.25 greater if samples were wrapped.

3/ Includes cost of tagging, which was incorporated with weighing operation.

4/ Cost of $0.94 for tagging was included, since tagging is a separate operation with this method of weighing.

Table 13.--Estimated variable and fixed cost of receiving 100 flat bales of cotton at typical warehouses, California-Arizona, 1971 1/

Type of cost	Travel 800 feet		Travel 1,000 feet	
	Stack 2-bales high	Stack 3-bales high	Stack 2-bales high	Stack 3-bales high
	Dollars			
Variable labor and equipment cost 2/..........	41.01	41.65	45.00	45.64
Other variable cost 3/.......	7.24	7.35	7.94	8.05
Total variable...........	48.25	49.00	52.94	53.69
Total fixed 4/...........	11.32	11.49	12.42	12.59
Total cost.................	59.57	60.49	65.36	66.28

1/ Based on use of 3-bale clamp trucks for unloading trailers and stacking bales in storage compartments, and for motor propelled beam scale for weighing.
2/ From table 12.
3/ Estimated at 15 percent of total variable cost based on (11, p. 9).
4/ Estimated at 19 percent of total cost based on (11, p. 9).

Performance of these same four operations at warehouses during receiving adds only $0.12 per bale to total receiving cost. Thus, these four services are performed at a low cost per bale at any one point. However, the total expense involved is much greater when bales are handled at the gins, hauled to warehouses, and unloaded and arranged in rows so that tagging, weighing, recording, and sampling are repeated before bales are moved into storage compartments.

If it can be assumed that these operations are accurately performed at the gins, there is really no sound argument for performing them at the warehouse. Thus, bales are actually ready for stacking in warehouse storage compartments as soon as they leave the gin platform.

Compression of bales to greater densities has been a service traditionally provided by cotton warehousing firms. A few gins in California and Arizona have presses that can package standard-density bales, and even fewer can press and package lint to high-density bales. However, with reasonably high ginning volumes, this additional cost of compression to greater densities at gins becomes relatively small per bale.

The recent introduction of the automatic gin press, capable of packaging lint to a density of 28-30 pounds, may eventually eliminate the need for warehouse compression. Besides lowering direct marketing cost for pressing and packaging cotton lint, use of this press would help reduce the chances of incurring additional fiber damage.

If a firm were to adopt the minor changes in operating practices that have been suggested, questions could be raised regarding the necessity and desirability of removing bales from the gin premises to some centrally located warehouse for storage. Most bales ginned in California and Arizona are handled five times from gin to warehouse storage compartment. At the gin platform, bales are manually loaded onto a small trailer, hauled to the gin bale yard, and unloaded for temporary storage. Later, they are reloaded onto a large, flat-bed motor transport and hauled to the warehouse where they are unloaded and placed in row blocks. Finally, they are picked up, moved to, and stacked in storage compartments.

If tagging, weighing, recording, and sampling operations could be eliminated at the warehouse, and if warehousing facilities were located adjacent to ginning plants, all but one of these handlings would be unnecessary. Bales could be moved by clamp truck from the gin directly into storage, thereby eliminating the conventional bale hauling operation. Sufficient production is implied to justify construction and operation of a warehouse of efficient size at or near the gin. Although no known work has been done in determining the most efficient size in warehouses, designs developed by USDA engineers suggest that plants with storage capacity of only 40,000 to 50,000 bales are economically feasible when such low volumes are involved, and that plants with at least twice this capacity are relatively efficient (2).

Adoption of these changes by a firm currently operating both gin plants and one or more warehouse plants would necessitate no changes in ownership structure. The firm could be privately, corporately, or cooperatively owned. In any case, relocating facilities and reorganizing services performed to attain greater efficiency and lower marketing costs should be advantageous to both owners and cotton producers.

Such changes in facilities might require corresponding changes in the managerial structure of the firm. If ginning and storing facilities were located at the same site, a highly capable plant manager would be needed to coordinate ginning and storing operations. Needs for lower level management personnel would vary depending on total volume processed, number of gin processing lines installed, specific services provided by the warehousing portion of the plant, and capabilities of individuals.

DESCRIPTION OF MODELS

In developing locational models for this report, a concerted effort was made to avoid additional steps in the market flow; such as, a massive, in-the-field seed cotton storage operation, lint quality determination from seed cotton samples, or precleaning and bale packing of seed cotton. Though some of these have been suggested in other studies (7, 8, and 15), such practices

tend to be substitutions, one for another, or additional operations. In either case, costly labor and equipment inputs are required.

Two major criteria held foremost in developing the locational models were (1) to reduce the number of times the product is handled from field to storage, thereby lessening labor and equipment requirements and fiber damage; and (2) to utilize the latest ginning and materials handling technologies to achieve greater economies of size. The assumed production area consisted of about 1,000 square miles with a production density of about 100 bales per square mile. For the peak 2-week harvest period, a total ginning capacity of 122 bales per hour would be required.

Four 36-bale gins equipped with automatic 28-30 pound density presses would provide the necessary capacity and, therefore, constituted the ginning facilities in both models. Density of gin packaged bales and whether the warehousing facility included a compress were irrelevant, since it was assumed that regardless of density, almost all bales would be moved to and stacked in storage compartments soon after ginning. 6/

In estimating capital requirements for these two models, storage compartments were excluded because the scope of the study was confined to the four principal marketing services which end with stacking of bales in a storage compartment. The physical structure of the warehousing facility and, hence, the capital requirements, were assumed to be the same whether the facility was operated conventionally or as an integral part of one of the two models. The fixed cost--$0.12 to $0.13 a bale--was estimated as accounting for approximately 19 percent of total warehouse receiving cost (table 13).

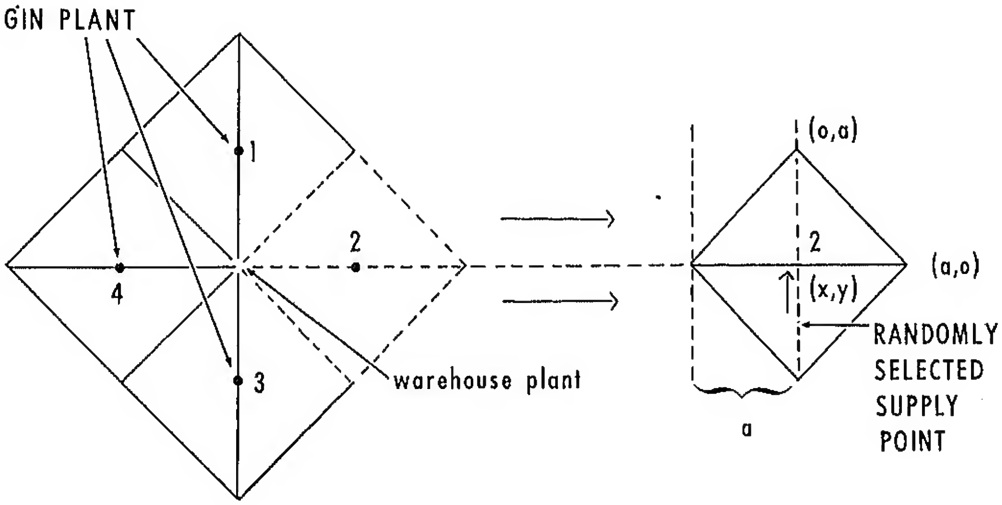
Locational Model I--Modified Conventional Arrangement

This model represents a modified arrangement of conventional ginning and warehousing facilities with some changes in operating practices. The square production area, shown as a baseball diamond to conform to the square grid road network, is divided into quadrants with the warehouse located at its center (figure). One 36-bale per hour gin plant is located at the center of each quadrant; each center point is 11.73 miles from the warehouse.

Duplication at the warehouse of the bale weighing, tagging, recording, and sampling operations, performed initially at the gin, was eliminated. Thus, as trucks arrive at the warehouse, they could be positioned and unloaded near the appropriate storage compartment and bales could be stacked in one continuous operation with the use of clamp trucks.

6/ Gin bale density would be very relevant in an economic analysis of services performed by warehouses after the initial stacking of bales in storage compartments.

LOCATIONAL MODEL I



Modified conventional ginning and warehousing arrangement recommended for square supply area (quadrant 2 is shown separately).
Each gin plant produces 36 bales per hour.

Capital Requirements and Ginning Costs

Capital requirements for establishing and erecting each of the 36-bale per hour gin plants were $998,000 (table 6). For four of these plants, the investment in ginning facilities totaled almost $4 million for the production area. Assuming a maximum seasonal volume at all four gins, the cost of ginning in this production area averaged $12.80 per bale (table 7).

Cost of Hauling Seed Cotton (10)

The road distance to or from a production point within any quadrant to the gin plant is (x + y), where x and y are the rectangular coordinates of the point (quadrant 2 in figure). Since production density (P_o) was assumed to be uniform throughout the area, average travel distance ($\overline{D}$) is

$$\overline{D} = \frac{4}{\text{area}} \int_o^a \int_o^{a-x} (x + y)\, dy\, dx$$

$$= \frac{4}{2a^2} \left(\frac{a^3}{3}\right) = \frac{2}{3}a$$

Total supply in relation to a is

$$S = 2\, P_o a^2$$

and

$$\overline{D} = \frac{2}{3} \sqrt{\frac{S}{2\, P_o}}$$

$$= .4714 \sqrt{\frac{S}{P_o}}$$

$$= .4714 \sqrt{\text{area}}$$

In the figure, the area for each quadrant is 275 square miles and $\overline{D}$ x 2 = 7.82 miles (one way) or 15.64 miles (round trip). Assuming an average of 10 trips per trailer annually, hauling seed cotton would cost $3.87 per bale. 7/

7/ Based on $2.79 (table 3) + ($0.0356 x 15.64 miles) + $0.5333. Average hauling distance and, hence, cost are slightly lower for a square supply area than for a circular area, although the differences are quite small.

Bale Hauling and Stacking Costs

Using the estimating equation, Y = 0.8 + X, cited earlier, hauling baled lint by motor transport a distance of 11.73 miles from gin to warehouse would cost $0.92 per bale.

Unloading bales from the truck and stacking them in storage compartments in one continuous operation is similar to the conventional practice of unloading and positioning bales in temporary row blocks in the warehouse receiving area. However, in most instances, the clamp-truck travel distances will be greater if bales are moved directly into storage compartments instead of row blocks in the receiving area. Also, there is less space for maneuvering clamp trucks in storage compartments, and proper stacking of bales would likely require more time than would positioning them in temporary row blocks. Finally, besides the clamp-truck operator, another worker may be needed to check the tag numbers on bales as they are unloaded--to verify the hauling invoice and validate receipt of bales.

Table 9 showed a cost of $6.77 for two men and a 3-bale clamp truck unloading 100 bales during the peak receiving period. Adjusting for slack time during the early and final weeks of the receiving period, average seasonal cost for this job was $9.86 per 100 bales. Assuming that it takes approximately twice as much time to unload and stack bales in storage compartments as it does to unload and position them in row blocks, the cost of "receiving" associated with Locational Model I was $19.72 per 100 bales, or about $0.20 per bale.

Total Cost

Table 14 summarizes total cost in this model for moving and processing cotton from the field through initial stacking of bales in storage compartments. If all four gin plants were operated at maximum seasonal capacity and seed cotton trailers were used an average of 10 trips per season, total operating cost for this model would be $17.80 per bale. At the same rate of gin capacity utilization but with an increase in number of trips per trailer from 10 to 14, total per bale cost would be reduced from $17.80 to $17.00.

Locational Model II--Ginning-Warehousing Complex

This model incorporates a proposed centralized and integrated ginning-warehousing facility in the same production area described for Locational Model I. Instead of four complete 36-bale per hour gin plants uniformly dispersed throughout the area, four 36-bale per hour gin processing lines were located adjacent to the warehouse at the center of the production area.

Table 14.--Locational Model I: Combined per bale costs for assembling seed cotton, ginning, hauling bales to warehouse, and warehouse receiving, by six different levels of potential annual output, California-Arizona, 1971 1/

Seasonal trips per trailer	Percentage level of potential annual output 2/					
	100	90	80	70	60	50
	Dollars					
1	42.93	43.58	44.33	45.36	46.70	48.52
2	28.97	29.62	30.37	31.40	32.74	34.56
3	24.32	24.97	25.72	26.75	28.09	29.91
4	21.99	22.64	23.39	24.42	25.76	27.58
5	20.59	21.24	21.99	23.02	24.36	26.18
6	19.66	20.31	21.06	22.09	23.43	25.25
7	19.00	19.65	20.40	21.43	22.77	24.59
8	18.50	19.15	19.90	20.93	22.27	24.09
9	18.11	18.76	19.51	20.54	21.87	23.70
10	17.80	18.45	19.20	20.23	21.57	23.39
11	17.55	18.20	18.95	19.98	21.32	23.14
12	17.34	17.99	18.74	19.77	21.11	22.93
13	17.16	17.81	18.56	19.59	20.93	22.75
14	17.00	17.65	18.40	19.43	20.77	22.59
15	16.87	17.52	18.27	19.30	20.64	22.46
16	16.75	17.40	18.15	19.18	20.52	22.34

1/ Computation of individual cost components as follows:
Seed cotton assembly--Average (round trip) distance of 15.64 miles with fixed costs of $167.50 for a 6-bale trailer; $0.5333 per bale (1.333 man-hours at $2.40) for labor; and variable costs per bale-mile of $0.0223 for truck and $0.0133 (0.0333 man-hours at $2.40) for labor.
Ginning--$12.80 at 100 percent seasonal capacity utilization, $13.45 at 90 percent, $14.20 at 80 percent, $15.23 at 70 percent, $16.57 at 60 percent, and $18.39 at 50 percent.
Hauling to warehouse--$0.92 for transporting baled lint a distance of 11.73 miles. Based on formula Y = 0.8 + X.
Warehouse receiving--$0.20 per bale for unloading, transporting, and stacking 3-high in storage compartments with a 3-bale clamp truck.
2/ Ginning costs, at other than full capacity, determined by using ratios from model gins. See (13).

Capital Requirements and Ginning Costs

Ginning facilities for this complex would be concentrated at one centrally located site in the production area. Thus, capital required for land, outside equipment, tools, and an office building and furnishings was estimated at only about 2 1/2 times that required for the single 36-bale per hour gin plant described in Locational Model I. However, cost of gin machinery and buildings would not be reduced and would run four times the single plant cost. Total investment cost in ginning facilities for Locational Model II was $3,845,000 (table 15). Total cost of ginning would be $11.52 per bale (table 16), compared with $12.80 for a single 36-bale gin.

Cost of Hauling Seed Cotton

Cost of hauling seed cotton would be greater than in Locational Model I because of the increase in average round trip hauling distance from 15.64 miles to 31.38 miles. This increase raised truck and labor costs from about $1.09 to $1.65 per bale. Trailer cost per bale remained the same, however, since it was assumed initially that the trailer was a fixed seasonal input. 8/

Cost of Moving Bales from Gins into Warehouse Compartments

Transporting bales with clamp trucks from gin bale platforms and stacking these bales in warehouse storage compartments would be similar to moving bales from row blocks into storage at a conventional warehousing plant. In either case, three major work elements are involved, although they are performed as one continuous operation--picking up, transporting, and stacking. Assuming the same stacking heights in both cases, the main difference would be in the transporting distances involved.

As indicated earlier, the variable inputs of labor and equipment and their costs were computed for transporting and stacking 100 bales at peak-of-season efficiency; these costs were adjusted upward 145.70 percent to determine seasonal average variable cost. 9/ Following this adjustment, average fixed cost of $13 was added to variable seasonal cost of handling and stacking 100 bales at the ginning-warehousing complex (table 17).

Based on the layout of a ginning-warehousing complex visualized here, a majority of the bales would be transported distances ranging from 1,000 to 2,000 feet and stacked 3-high. Thus, with a 4-bale clamp truck, bales could be moved from platforms in the gin processing lines to storage compartments and stacked at a cost of $0.34 per bale. The average transporting distance was 1,500 feet.

8/ Assumes that farmers would need no extra trailers though hauling time and distance were increased.

9/ These were the only variable inputs considered, since it was assumed that labor and equipment account for at least 85 percent of total variable cost.

Table 15.--Locational Model I: Estimated capital requirements for four 36-bale gin processing lines operated with a compress-warehouse operation, California-Arizona, 1971 1/

Capital item	Capital investment
	Dollars
Land 2/	75,000
Gin buildings 3/	520,000
Gin machinery	3,080,000
Outside equipment 4/	100,000
Tools	15,000
Office buildings 5/	55,000
Total	3,845,000

1/ Derived from (13).
2/ 75 acres at $1,000 per acre.
3/ Includes foundations.
4/ Includes cyclones, piping, seed hopper, tractor, truck, and auto.
5/ Includes furniture, fixtures, and scales.

Total Cost

Combined cost of hauling seed cotton, ginning, and bale storing associated with a ginning-warehousing complex and seasonal trailer usage ranged from $41.43 per bale for one trip per trailer to $16.30 per bale for 10 trips per trailer (table 18). All four gin processing lines were assumed operating at maximum seasonal volume.

EVALUATION OF MODELS

Costs associated with each of the two models could have been compared with any of the other 648 figures for current total cost of seed cotton hauling, ginning, bale hauling, and warehouse receiving (app. tables 1 through 6). However, 18 of these figures provided an adequate basis for evaluating efficiency and costs of the models. These data were total costs associated with three different-sized gins operated at six different levels of potential seasonal volume (table 19). Costs were also computed for six different levels of seasonal output for the models.

Table 16.--Locational Model II: Annual total and unit costs of operating four 36-bale gin processing lines at a ginning-warehousing complex, California-Arizona, 1971 1/

Cost item	Total cost	Cost per bale
	Dollars	
Fixed cost:		
Depreciation	188,500	1.70
Interest	137,200	1.24
Insurance	38,975	.35
Taxes	63,058	.57
Management	116,160	1.05
Subtotal	543,893	4.91
Variable cost:		
Labor	161,784	1.46
Energy	58,241	.53
Packaging material	277,200	2.50
Repairs	130,840	1.18
Miscellaneous	103,950	.94
Subtotal	732,015	6.61
Total costs	1,275,908	11.52

1/ Assuming maximum seasonal capacity utilization. Methods and rates used for computing costs were same as those used in computing costs associated with conventional gin plant.

Assuming that maximum seasonal ginning volume is achieved and that trailers are used 10 times per season, cost of providing the four marketing services conventionally with a 12-bale per hour gin plant was $21.16 a bale. The cost for Locational Model I was $17.80 per bale and that for Locational Model II was $16.30.

It seems more realistic, however, to assume that ginning facilities associated with the locational models would process approximately 90 percent of potential seasonal volume on the average while conventional facilities might process only about 60 percent of such potential. Given these assumptions, cost per bale of providing the four marketing services conventionally, including use of a 12-bale per hour gin plant, was $25.40, compared with $16.85 for Locational Model II and $18.45 for Locational Model I. Differences in per bale costs were $8.55 and $6.95, respectively.

Table 17.--Locational Model II: Inputs and costs of labor and equipment for transporting and stacking 100 flat bales at a ginning-warehousing complex by selected combinations of inputs, California-Arizona, 1971 1/

Item 2/	Time required 3/	Cost at peak of season 3/			Adjusted total seasonal cost 4/
		Equipment	Labor	Equipment and labor	
	Hours	- - - - - - - - - - Dollars	- - - - - - - - -		
1 man, 3-bale truck with stack 2-bales high and travel distance of--					
500 feet	1.12	3.70	4.37	8.07	30.70
1,000 feet	2.06	6.80	8.03	14.83	40.55
1,500 feet	2.99	9.87	11.66	21.53	50.31
2,000 feet	3.93	12.97	15.33	28.30	60.17
Stack 3-bales high and travel distance of--					
500 feet	1.18	3.89	4.60	8.49	31.31
1,000 feet	2.12	7.00	8.27	15.27	41.19
1,500 feet	3.05	10.06	11.90	21.96	50.93
2,000 feet	3.99	13.17	15.56	28.73	60.80
1 man, 4-bale truck with stack 2-bales high and travel distance of--					
500 feet	.60	1.98	2.34	4.32	25.23
1,000 feet	.98	3.23	3.82	7.05	29.21
1,500 feet	1.37	4.52	5.34	9.86	33.30
2,000 feet	1.75	5.78	6.82	12.60	37.30
Stack 3-bales high and travel distance of--					
500 feet	.67	2.21	2.61	4.82	25.96
1,000 feet	1.06	3.50	4.13	7.63	30.06
1,500 feet	1.44	4.75	5.62	10.37	34.05
2,000 feet	1.83	6.04	7.14	13.18	38.14

1/ Input data derived from (19, pp. 42-44).
2/ Bales stacked in "onhead" or "onend" upright position.
3/ Peak season inputs and costs. Equipment costs based on rental rate of $3.30 per machine-hour for 3- and 4-bale clamp trucks. Labor cost based on unit cost of $3.90 per man-hour.
4/ Because inputs were paid for but not fully used during early and late weeks of season, peak season variable costs were increased 45.70 percent; fixed cost of $13 per 100 bales included.

Table 18.--Locational Model II: Combined per bale costs associated with ginning-warehousing complex for assembling seed cotton, ginning, hauling bales to warehouse, and warehouse receiving, potential annual output, California-Arizona, 1971 1/

Seasonal trips per trailer	Percentage level of potential annual output 2/					
	100	90	80	70	60	50
	Dollars					
1........	41.43	41.98	42.70	43.59	44.75	46.37
2........	27.47	28.02	28.74	29.63	30.79	32.41
3........	22.82	23.37	24.09	24.98	26.14	27.76
4........	20.49	21.04	21.76	22.65	23.81	25.43
5........	19.09	19.64	20.36	21.25	22.41	24.03
6........	18.16	18.71	19.43	20.32	21.48	23.10
7........	17.50	18.05	18.77	19.66	20.82	22.44
8........	17.00	17.55	18.27	19.16	20.32	21.94
9........	16.61	17.16	17.88	18.77	19.93	21.55
10........	16.30	16.85	17.57	18.46	19.62	21.24
11........	16.05	16.60	17.32	18.21	19.37	20.99
12........	15.84	16.39	17.11	18.00	19.16	20.78
13........	15.66	16.21	16.93	17.82	18.98	20.60
14........	15.50	16.05	16.77	17.66	18.82	20.44
15........	15.37	15.92	16.64	17.53	18.69	20.31
16........	15.25	15.80	16.52	17.41	18.57	20.19

1/ Computation of individual cost components as follows:
Seed cotton assembly--Average (round trip) distance of 31.38 miles with fixed cost of $167.50 for 6-bale trailer; $0.5333 per bale (1.333 man-hours at $2.40) for labor; and variable costs per bale-mile of $0.0223 for truck and $0.0133 (0.033 man-hours at $2.40) for labor.
Ginning--$11.52 at 100 percent seasonal capacity utilization, $12.07 at 90 percent, $12.79 at 80 percent, $13.68 at 70 percent, $14.84 at 60 percent, and $16.46 at 50 percent.
Moving baled lint from gin to warehouse storage compartment--$0.34 for average inplant transportation from gin platform to warehouse of 1,500 feet and stacking 3-high with 4-bale clamp truck.

2/ Ginning costs, at other than full capacity, determined by using ratios from model gins. See (13).

Table 19.--Comparison of per bale costs for performing four marketing services among five different ginning-warehousing arrangements, California-Arizona, 1971 1/

Ginning-warehousing arrangement	Percentage level of potential annual output					
	100	90	80	70	60	50
	-Dollars-					
12-bale conventional 2/..	21.16	21.88	22.76	23.90	25.40	27.45
18-bale conventional 3/..	20.07	20.70	21.53	22.57	23.92	25.78
24-bale conventional 4/..	19.65	20.30	21.09	22.09	23.45	25.28
Locational Model I 5/....	17.80	18.45	19.20	20.23	21.57	23.39
Locational Model II 6/...	16.30	16.85	17.57	18.46	19.62	21.24

1/ Three conventional and two proposed models; 10 seasonal trips per trailer in seed cotton assembly for each. Marketing services include: (1) hauling seed cotton from field to gin, (2) ginning and packaging, (3) moving baled lint to warehouses, and (4) warehouse receiving.
2/ See app. table 2.
3/ See app. table 3.
4/ See app. table 4.
5/ See table 14.
6/ See table 18.

Although potential savings from use of Locational Model II are greater, Locational Model I may be more acceptable to various segments of the trade because of the relative conventionality. Though the concept suggested in Locational Model II departs completely from current ginning-warehousing relationships, Locational Model I proposes nothing revolutionary other than newly developed, higher capacity gin plants with automatic gin presses, some consolidation and relocation of facilities, and elimination of duplicate weighing, tagging, sampling, and recording.

Regardless of which concept is favored, when warehousing and ginning facilities are inadequate or may soon have to be relocated, serious consideration should be given to adopting one of these two models incorporating different-sized facilities to meet specific needs.

APPENDIX: SUGGESTIONS FOR ADDITIONAL RESEARCH

Possibilities for further reductions in cost of marketing cotton associated with centralized ginning facilities (Locational Model I) or ginning-warehousing complexes (Locational Model II) may greatly exceed those enumerated in this report. Because of the concentration of physical facilities, managerial personnel, and labor, other related cotton production and marketing services could be integrated logically into the operations of either model. In addition, other cotton marketing practices and services should be examined to identify needed changes and determine their cost-reduction potentials. Suggestions for further research are summarized below.

Warehousing and Transportation

Baled cotton is stored in warehouses following ginning and then transported to domestic mills or export docks as needed throughout the remainder of the year. Though essential, these marketing services are not always performed most efficiently. An analysis could be made of alternative input combinations for providing warehousing services to help pinpoint changes which would result in lower costs. Additionally, all facets of transporting bales from warehouses to mills could be studied to detect inefficiencies. Findings from these analyses should be interwoven into feasible warehousing-transportation models which would minimize combined cost of these services.

Bale Packaging and Density

In 1949, cost of packaging bales to gin standard density was shown to be less than the cost for packaging gin-flat bales plus the charge for compression to standard density (12). Despite these findings, bale packaging practices have not changed appreciably. Additionally, a majority of U.S. bales continue to be pressed to gin-flat density initially and later to higher density for ultimate shipment. Further research is needed to determine why more ginning firms have not incorporated higher density presses.

If "universal" density and lighter weight bales available with the automatic gin press discussed earlier prove acceptable for both domestic and export purposes, compress services may become unnecessary eventually (6). Not only would marketing costs be reduced but also one of the principal constraints to relocating warehouse storage compartments required in Locational Model II would be eliminated--the investment in compress facilities.

Utilization of Empty Warehouse Space for Seed Cotton Storage

A loan program for upland and America
producers in reducing costs of harvest
initiated by USDA during 1971. This a
in seed cotton storage as a means of r

Bulk stacking of seed cotton in the gin yard and basket storage of se cotton to extend the ginning season, thus increasing annual ginning volume without altering ginning capacities, has had varying degrees of success ov the years. Unfortunately, investment costs for seed cotton storage facili have tended to approximate investment costs for additional gin processing pacity. Most ginning firms with inadequate seasonal capacities have elect increase their ginning rate capabilities rather than add storage faciliti

In Locational Model II, availability of storage compartments for bale lint is an essential requirement. Assuming that most of the previous crop baled lint was shipped out prior to the harvesting-ginning season, empty s space in varying amounts would be available for other purposes. Use of th vacant space to store seed cotton temporarily would extend the normal ginn season, thus increasing seasonal capacity of a given gin plant and spreadi out fixed costs over more bales.

The amount of additional labor and other variable inputs needed to op materials handling equipment and the extent to which construction of wareh will have to be modified to render them adaptable for temporary storage of cotton will have to be determined. Then a full evaluation can be made of utilizing empty warehouse space for storing seed cotton.

Integration of Cottonseed Oil Mill with Locational Model II

An average volume of 44,000 tons of cottonseed for Locational Model I should be sufficient to keep a typical oil mill in the California-Arizona operating 9 to 10 months a year (16). Including an oil mill of this capac with the ginning-warehousing complex could further eliminate many of the l and capital inputs required for handling and hauling cottonseed. Implemen and potential of this proposal need to be thoroughly analyzed.

Reducing Cost of Assembling Seed Cotton

Because of the relatively high cost of seed cotton trailers and their limited adaptability to other uses, alternatives for reducing inefficienci associated with seed cotton hauling should be studied. Hopefully, such re would lead to development of more versatile hauling equipment, alternative ownership arrangements, or both, which would increase utilization and redu total cost.

Appendix table 1.--Combined cost per bale for four marketing services at nine levels of seed cotton trailer usage with round trip average distance of 6.41 miles, California-Arizona, 1971 1/

Trailer usage and gin-to-warehouse distance	Percentage level of potential annual output 2/					
	100	90	80	70	60	50
	Dollars					
1-trailer use:						
Bale-haul 40 miles	49.39	50.36	51.56	53.11	55.13	58.06
80 miles	49.79	50.76	51.96	53.51	55.53	58.46
2-trailer use:						
Bale-haul 40 miles	35.43	36.40	37.60	39.15	41.17	44.10
80 miles	35.83	36.80	38.00	39.55	41.57	44.50
4-trailer use:						
Bale-haul 40 miles	28.45	29.42	30.62	32.17	34.19	37.12
80 miles	28.85	29.82	31.02	32.57	34.59	37.52
6-trailer use:						
Bale-haul 40 miles	26.13	27.10	28.30	29.85	31.87	34.80
80 miles	26.53	27.50	28.70	30.25	32.27	35.20
8-trailer use:						
Bale-haul 40 miles	24.96	25.93	27.13	28.68	30.70	33.63
80 miles	25.36	26.33	27.53	29.08	31.10	34.03
10-trailer use:						
Bale-haul 40 miles	24.14	25.11	26.31	27.86	29.88	32.81
80 miles	24.54	25.51	26.71	28.26	30.28	33.21
12-trailer use:						
Bale-haul 40 miles	23.68	24.65	25.85	27.40	29.42	32.35
80 miles	24.08	25.05	26.25	27.80	29.82	32.75
14-trailer use:						
Bale-haul 40 miles	23.35	24.32	25.52	27.07	29.09	32.02
80 miles	23.75	24.72	25.92	27.47	29.49	32.42
16-trailer use:						
Bale-haul 40 miles	23.10	24.07	25.27	26.82	28.84	31.77
80 miles	23.50	24.47	25.67	27.22	29.24	32.17

1/ 6-bale per hour gin plant at 6 different levels of seasonal output; 2 gin-to-warehouse bale hauling distances; and warehouse travel of 1,000 feet to stack bales 3-high. Assumed that seed cotton trailer loads equivalent to 6 bales of lint; bales hauled to warehouse in full loads; warehouse unloading and handling performed with 3-bale clamp truck; bales weighed with motor propelled beam scale.

2/ The 100-percent level of potential annual output defined as 85 percent of rated capacity by gin machinery manufacturers.

Appendix table 2.—Combined cost per bale for four marketing services at nine levels of seed cotton trailer usage with round trip average distance of 9.06 miles, California-Arizona, 1971 1/

Trailer usage and gin-to-warehouse distance	Percentage level of potential annual output 2/					
	100	90	80	70	60	50
	Dollars					
1-trailer use:						
Bale-haul 40 miles	46.29	47.01	47.89	49.03	50.53	52.58
80 miles	46.69	47.41	48.29	49.43	50.93	52.98
2-trailer use:						
Bale-haul 40 miles	32.33	33.05	33.93	35.07	36.57	38.62
80 miles	32.73	33.45	34.33	35.47	36.97	39.02
4-trailer use:						
Bale-haul 40 miles	25.35	26.07	26.95	28.09	29.59	31.64
80 miles	25.75	26.47	27.35	28.49	29.99	32.04
6-trailer use:						
Bale-haul 40 miles	23.02	23.74	24.62	25.76	27.26	29.31
80 miles	23.42	24.14	25.02	26.16	27.66	29.71
8-trailer use:						
Bale-haul 40 miles	21.86	22.58	23.46	24.60	26.10	28.15
80 miles	22.26	22.98	23.86	25.00	26.50	28.55
10-trailer use:						
Bale-haul 40 miles	21.16	21.88	22.76	23.90	25.40	27.45
80 miles	21.56	22.28	23.16	24.30	25.80	27.85
12-trailer use:						
Bale-haul 40 miles	20.70	21.42	22.30	23.44	24.94	26.99
80 miles	21.10	21.82	22.70	23.84	25.34	27.39
14-trailer use:						
Bale-haul 40 miles	20.36	21.08	21.96	23.10	24.60	26.65
80 miles	20.76	21.48	22.36	23.50	25.00	27.05
16-trailer use:						
Bale-haul 40 miles	20.11	20.83	21.71	22.85	24.35	26.40
80 miles	20.51	21.23	22.11	23.25	24.75	26.80

1/ 12-bale per hour gin plant at 6 different levels of seasonal output; 2 gin-to-warehouse bale hauling distances; and warehouse travel of 1,000 feet to stack bales 3-high. Assumed that seed cotton trailer loads equivalent to 6 bales of lint; bales hauled to warehouse in full loads; warehouse unloading and handling performed with 3-bale clamp truck; bales weighed with motor propelled beam scale.

2/ The 100-percent level of potential annual output defined as 85 percent of rated capacity by gin machinery manufacturers.

Appendix table 3.--Combined cost per bale for four marketing services at nine levels of seed cotton trailer usage with round trip average distance of 11.10 miles, California-Arizona, 1971 1/

Trailer usage and gin-to-warehouse distance	Percentage level of potential annual output 2/					
	100	90	80	70	60	50
	Dollars					
1-trailer use:						
Bale-haul 40 miles	45.20	45.83	46.66	47.70	49.05	50.91
80 miles	45.60	46.23	47.06	48.10	49.45	51.31
2-trailer use:						
Bale-haul 40 miles	31.24	31.87	32.70	33.74	35.09	36.95
80 miles	31.64	32.27	33.10	34.14	35.49	37.35
4-trailer use:						
Bale-haul 40 miles	24.26	24.89	25.72	26.76	28.11	29.97
80 miles	24.66	25.29	26.12	27.16	28.51	30.37
6-trailer use:						
Bale-haul 40 miles	21.93	22.56	23.39	24.43	25.78	27.64
80 miles	22.33	22.96	23.79	24.83	26.18	28.04
8-trailer use:						
Bale-haul 40 miles	20.77	21.40	22.23	23.27	24.62	26.48
80 miles	21.17	21.80	22.63	23.67	25.02	26.88
10-trailer use:						
Bale-haul 40 miles	20.07	20.70	21.53	22.57	23.92	25.78
80 miles	20.47	21.10	21.93	22.97	24.32	26.18
12-trailer use:						
Bale-haul 40 miles	19.51	20.14	20.97	22.01	23.36	25.22
80 miles	19.91	20.54	21.37	22.41	23.76	25.62
14-trailer use:						
Bale-haul 40 miles	19.28	19.91	20.74	21.78	23.13	24.99
80 miles	19.68	20.31	21.14	22.18	23.53	25.39
16-trailer use:						
Bale-haul 40 miles	19.03	19.66	20.49	21.53	22.88	24.74
80 miles	19.43	20.06	20.89	21.93	23.28	25.14

1/ 18-bale per hour gin plant at 6 different levels of seasonal output; 2 gin-to-warehouse bale hauling distances; and warehouse travel of 1,000 feet to stack bales 3-high. Assumed that seed cotton trailer loads equivalent to 6 bales of lint; bales hauled to warehouse in full loads; warehouse unloading and handling performed with 3-bale clamp truck; bales weighed with motor propelled beam scale.

2/ The 100-percent level of potential annual output defined as 85 percent of rated capacity by gin machinery manufacturers.

Appendix table 4.--Combined cost per bale for four marketing services at nine levels of seed cotton trailer usage with round trip average distance of 12.82 miles, California-Arizona, 1971 1/

Trailer usage and gin-to-warehouse distance	Percentage level of potential annual output 2/					
	100	90	80	70	60	50
	Dollars					
1-trailer use:						
Bale-haul 40 miles	44.78	45.43	46.22	47.22	48.58	50.41
80 miles	45.18	45.83	46.62	47.62	48.98	50.91
2-trailer use:						
Bale-haul 40 miles	30.82	31.47	32.26	33.26	34.62	36.45
80 miles	31.22	31.87	32.66	33.66	35.02	36.85
4-trailer use:						
Bale-haul 40 miles	23.84	24.49	25.28	26.28	27.64	29.47
80 miles	24.24	24.89	25.68	26.68	28.04	29.87
6-trailer use:						
Bale-haul 40 miles	21.52	22.17	22.96	23.96	25.32	27.15
80 miles	21.92	22.57	23.36	24.36	25.72	27.55
8-trailer use:						
Bale-haul 40 miles	20.35	21.00	21.79	22.79	24.15	25.98
80 miles	20.75	21.40	22.19	23.19	24.55	26.38
10-trailer use:						
Bale-haul 40 miles	19.65	20.30	21.09	22.09	23.45	25.28
80 miles	20.05	20.70	21.49	22.49	23.85	25.68
12-trailer use:						
Bale-haul 40 miles	19.19	19.84	20.63	21.63	22.99	24.82
80 miles	19.59	20.24	21.03	22.03	23.39	25.22
14-trailer use:						
Bale-haul 40 miles	[illegible]	19.51	20.30	21.30	22.66	24.49
80 miles	[illegible]	[illegible]	20.70	21.70	23.06	24.89
16-trailer use:						
Bale-haul 40 miles	[illegible]	[illegible]	20.05	21.05	22.41	24.24
80 miles	[illegible]	[illegible]	20.45	21.45	22.81	24.64

1/ 24-bale per hour gin plant at 6 diffe[illegible] levels of seasonal output; 2 gin-to-warehouse bale hauling distances; and warehouse travel of 1,000 feet to stack bales 3-high. Assumed that seed cotton trailer loads equivalent to 6 bales of lint; bales hauled to warehouse in full loads; warehousing unloading and handling performed with 3-bale clamp truck; bales weighed with motor propelled beam scale.

Appendix table 5.--Combined cost per bale for four marketing services at nine levels of seed cotton trailer usage with round trip average distance of 14.33 miles, California-Arizona, 1971 1/

Trailer usage and gin-to-warehouse distance	Percentage level of potential annual output 2/					
	100	90	80	70	60	50
	Dollars					
1-trailer use:						
Bale-haul 40 miles	43.91	44.55	45.36	46.35	47.67	49.52
80 miles	44.31	44.95	45.76	46.75	48.07	49.92
2-trailer use:						
Bale-haul 40 miles	29.95	30.59	31.40	32.39	33.71	35.56
80 miles	30.35	30.99	31.80	32.79	34.11	35.96
4-trailer use:						
Bale-haul 40 miles	22.98	23.62	24.43	25.42	26.74	28.59
80 miles	23.38	24.02	24.83	25.82	27.14	28.99
6-trailer use:						
Bale-haul 40 miles	20.65	21.29	22.10	23.09	24.41	26.26
80 miles	21.05	21.69	22.50	23.49	24.81	26.66
8-trailer use:						
Bale-haul 40 miles	19.49	20.13	20.94	21.93	23.25	25.10
80 miles	19.89	20.53	21.34	22.33	23.65	25.50
10-trailer use:						
Bale-haul 40 miles	18.79	19.43	20.24	21.23	22.55	24.40
80 miles	19.19	19.83	20.64	21.63	22.95	24.80
12-trailer use:						
Bale-haul 40 miles	18.32	18.96	19.77	20.76	22.08	23.93
80 miles	18.72	19.36	20.17	21.16	22.48	24.33
14-trailer use:						
Bale-haul 40 miles	17.99	18.63	19.44	20.43	21.75	23.60
80 miles	18.39	19.03	19.84	20.83	22.15	24.00
16-trailer use:						
Bale-haul 40 miles	17.74	18.38	19.19	20.18	21.50	23.35
80 miles	18.14	18.78	19.59	20.58	21.90	23.75

1/ 30-bale per hour gin plant at 6 different levels of seasonal output; 2 gin-to-warehouse bale hauling distances; and warehouse travel of 1,000 feet to stack bales 3-high. Assumed that seed cotton trailer loads equivalent to 6 bales of lint; bales hauled to warehouse in full loads; warehousing unloading and handling performed with 3-bale clamp truck; bales weighed with motor propelled beam scale.

2/ The 100-percent level of potential annual output defined as 85 percent of rated capacity by gin machinery manufacturers.

Appendix table 6.--Combined cost per bale for four marketing services at nine levels of seed cotton trailer usage with round trip average distance of 15.64 miles, California-Arizona, 1971 1/

Trailer usage and gin-to-warehouse distance	Percentage level of potential annual output 2/					
	100	90	80	70	60	50
	-Dollars-					
1-trailer use:						
Bale-haul 40 miles	43.67	44.32	45.13	46.10	47.44	49.26
80 miles	44.07	44.72	45.53	46.50	47.84	49.66
2-trailer use:						
Bale-haul 40 miles	29.71	30.36	31.17	32.14	33.48	35.30
80 miles	30.11	30.76	31.57	32.54	33.88	35.70
4-trailer use:						
Bale-haul 40 miles	22.73	23.38	24.19	25.16	26.50	28.32
80 miles	23.13	23.78	24.59	25.56	26.90	28.72
6-trailer use:						
Bale-haul 40 miles	20.41	21.06	21.87	22.84	24.18	26.00
80 miles	20.81	21.46	22.27	23.24	24.58	26.40
8-trailer use:						
Bale-haul 40 miles	19.24	19.89	20.70	21.67	23.01	24.83
80 miles	19.64	20.29	21.10	22.07	23.41	25.23
10-trailer use:						
Bale-haul 40 miles	18.54	19.19	20.00	20.97	22.31	24.13
80 miles	18.94	19.59	20.40	21.37	22.71	24.53
12-trailer use:						
Bale-haul 40 miles	18.08	18.73	19.54	20.51	21.85	23.67
80 miles	18.48	19.13	19.94	20.91	22.25	24.07
14-trailer use:						
Bale-haul 40 miles	17.75	18.40	19.21	20.18	21.52	23.34
80 miles	18.15	18.80	19.61	20.58	21.92	23.74
16-trailer use:						
Bale-haul 40 miles	17.50	18.15	18.96	19.93	21.27	23.09
80 miles	17.90	18.55	19.36	20.33	21.67	23.49

1/ 36-bale per hour gin plant at 6 different levels of seasonal output; 2 gin-to-warehouse bale hauling distances; and warehouse travel of 1,000 feet to stack bales 3-high. Assumed that seed cotton trailer loads equivalent to 6 bales of lint; bales hauled to warehouse in full loads; warehousing unloading and handling performed with 3-bale clamp truck; bales weighed with motor propelled beam scale.

2/ The 100-percent level of potential annual output defined as 85 percent of rated capacity by gin machinery manufacturers.

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